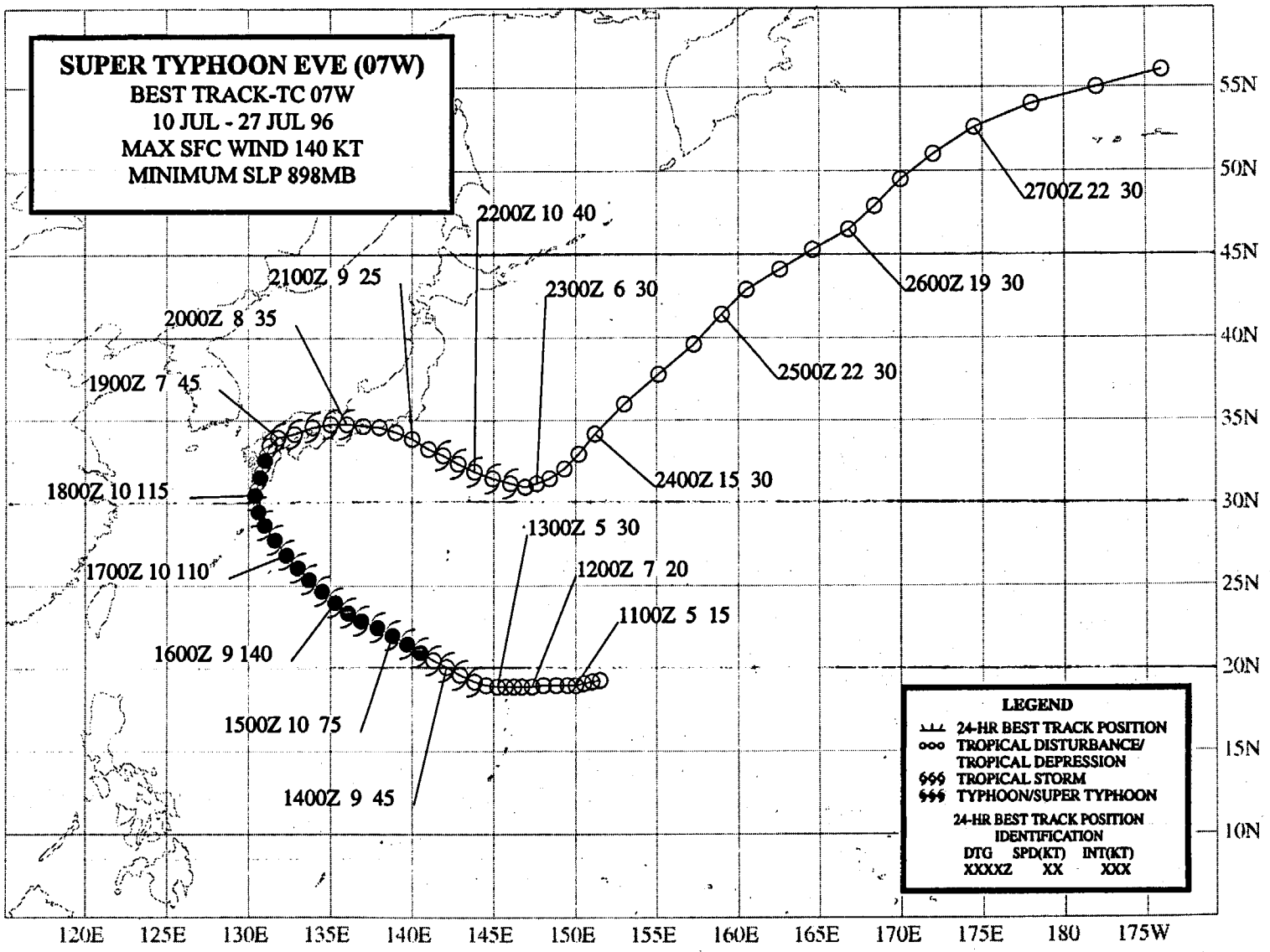
SUPER TYPHOON EVE (07W)
BEST TRACK-TC 07W
10 JUL - 27 JUL 96
MAX SFC WIND 140 KT
MINIMUM SLP 898MB
2200Z 10 40
2100Z 9 25
2300Z 6 30
2000Z 8 35
2700Z 22 30
2600Z 19 30
2500Z 22 30
1900Z 7 45
2400Z 15 30
1800Z 10 115
1300Z 5 30
1700Z 10 110
1200Z 7 20
1100Z 5 15
1600Z 9 140
1500Z 10 75
1400Z 9 45
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/ TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XXX
55N
50N
45N
40N
35N
30N
25N
20N
15N
10N
120E
125E
130E
135E
140E
145E
150E
155E
160E
165E
170E
175E
180
175W

SUPER TYPHOON EVE (07W)

I. HIGHLIGHTS

Eve, like Dan (06W) which preceded it, originated in association with a TUTT cell. After undergoing explosive deepening, Eve became the first WNP super typhoon of 1996. The typhoon passed through the northern Ryukyu Islands and made landfall in southern Japan. Moving eastward over Japan, the system weakened before intensifying to tropical storm intensity after moving offshore.

II. TRACK AND INTENSITY

As Dan was recurving to the east of Japan, a TUTT cell formed to its southeast. A band of deep convection formed a "U" shape to the south of this TUTT cell (Figure 3-07-1). Although not mentioned until 120600Z July on the Significant Tropical Weather Advisory, the disturbance which became Eve was tracked in post analysis back to the place where, at 100600Z, it consolidated in the TUTT-related area of deep convection. On 13 July, an area of persistent deep convection located about 300 nm (550 km) to the north of Guam, began to show signs of increasing organization. Synoptic data indicated that a low-level cyclonic circulation was located within this area of deep convection, and the JTWC issued a Tropical Cyclone Formation Alert valid at 130800Z July. During the night of 13 July, the persistent area of deep convection became well-organized, and satellite intensity estimates of 25 kt (13 m/sec) (later adjusted to 35 kt (18 m/sec) in post analysis) prompted the JTWC to issue the first warning on Tropical Depression (TD) 07W, valid at 131200Z.

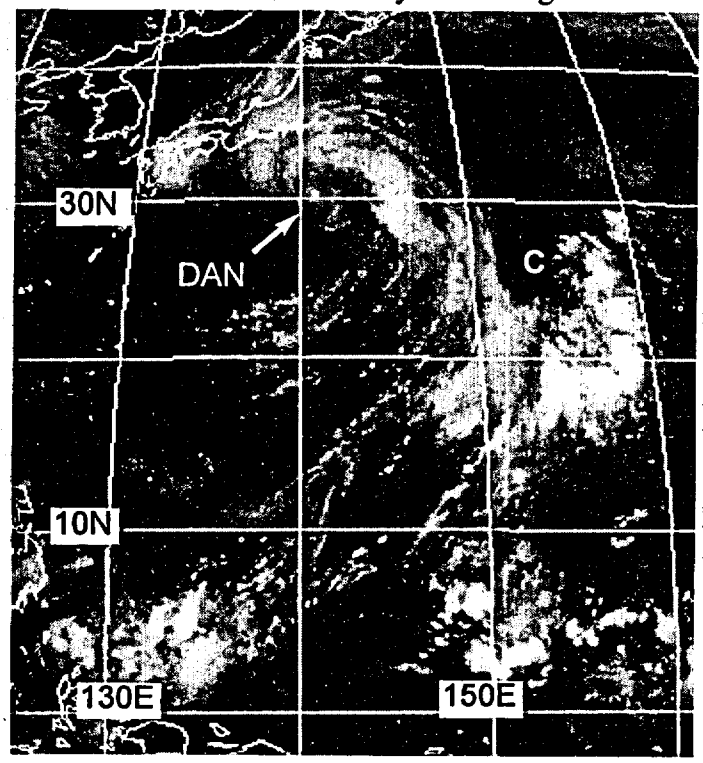

Figure 3-07-1 The tropical disturbance that became Eve originated from an area of deep convection to the south of a TUTT cell (C). This TUTT cell was, in turn, located to the southeast of the recurving Dan (06W) (091831Z July infrared GMS imagery).

When Eve formed a beautiful banding eye on the morning of 15 July (Figure 3-07-2), it was upgraded to a typhoon on the warning valid at 150000Z. From 150000Z to 160000Z, Eve underwent a period of explosive deepening (see the discussion section). At 151800Z, it became a super typhoon, and at 160000Z it reached its peak intensity of 140 kt (72 m/sec) (Figure 3-07-3). Forming concentric wall clouds (Figure 3-07-4), the intensity decreased to 100 kt (51 m/sec) by 170600Z. Just prior to making landfalling at Kyushu, Japan, on 18 July, the eye once again became small and well defined, and the intensity increased to 115 kt (59 m/sec). The system made landfall at approximately 180300Z and began to weaken over the mountainous terrain of Kyushu. The system was downgraded to a tropical storm at 191200Z, and the final warning was issued, valid at 200000Z, as the system moved eastward over the main Japanese island of Honshu and weakened.

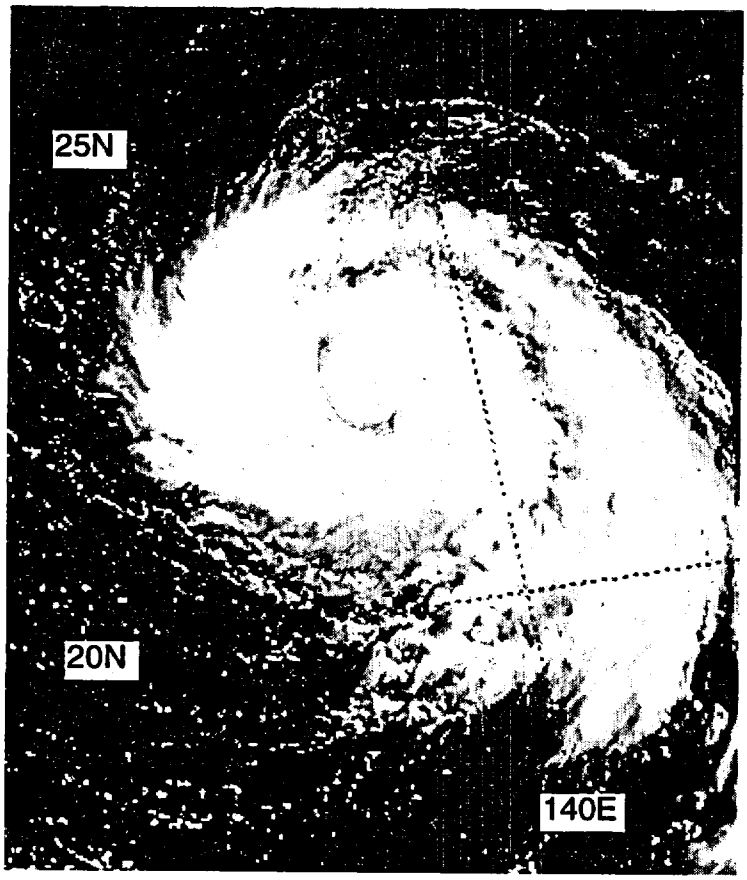

Figure 3-07-2 Eve forms a text-book quality banding eye pattern (150019Z July visible DMSP imagery).

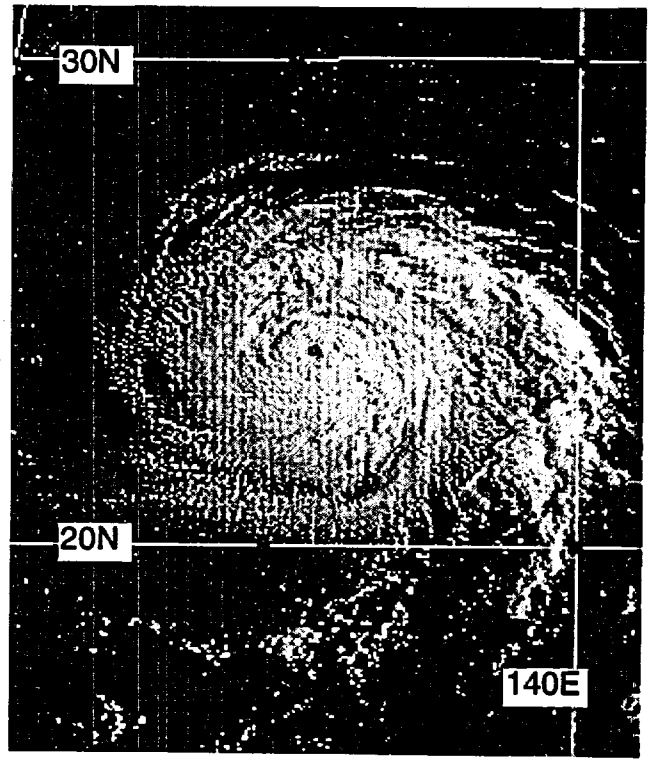

Figure 3-07-3 Eve at its peak intensity 140 kt (72 m/sec) (152131Z July visible GMS imagery).

When the system moved over water to the east of Japan, it regenerated. A post analysis of synoptic data, and a reanalysis of satellite imagery (e.g., Figure 3-07-5), supported a regeneration to tropical-storm intensity for the 24-hour period 211200Z to 221200Z, with a maximum intensity of 40 kt (21 m/sec) at 211800Z. After 251200Z, all deep convection was sheared away from the LLCC, marking the completion of extratropical transition. The system was identifiable on satellite imagery as it tracked all the way to the Aleutian Island chain where hourly data from Shemya (WMO 70414) indicated a small pressure fall and a wind shift attributable to the remnants of Eve passing to the southeast on 27 July.

III. DISCUSSION

a. *TUTT-related genesis*

Eve, like Dan (06W) which preceded it by a week, originated in association with a TUTT cell. Typical of TCs which develop in association with TUTT cells, Eve formed at a relatively high latitude (20°N), and it formed in the cloud-minimum region north of the cloudiness associated with the monsoon trough. For a more complete discussion of TUTT-related TC genesis, see Carlo's (33W) summary. In Carlo's (33W) case, and also in the case of Joy (12W), water-vapor imagery very clearly depicted the process of TC genesis from a TUTT cell.

b. *Explosive deepening*

Between 150000Z and 160000Z July, Eve's intensity increased from 75 kt (39 m/sec) to 140 kt (72 m/sec). The equivalent 24-hour pressure fall (using Atkinson and Holliday's (1977) wind-pressure relationship) was 70 mb, resulting in an average decrease of 2.92 mb/hr. This rate of pressure fall easily qualifies as a case of explosive deepening which is described by Dunnavan (1981) as a decrease in the minimum sea-level pressure of a TC of 2.5 mb/hr for at least 12 hours or 5 mb/hr for at least six hours. If one honors the digital Dvorak (DD) time series at this time (Figure 3-07-6), the rate of intensity increase is even more remarkable: the DD numbers at 150000Z were on the order of T 4.5, and then rose to their peak of approximately T 7.5 at 151800Z. The equivalent pressure fall using the DD

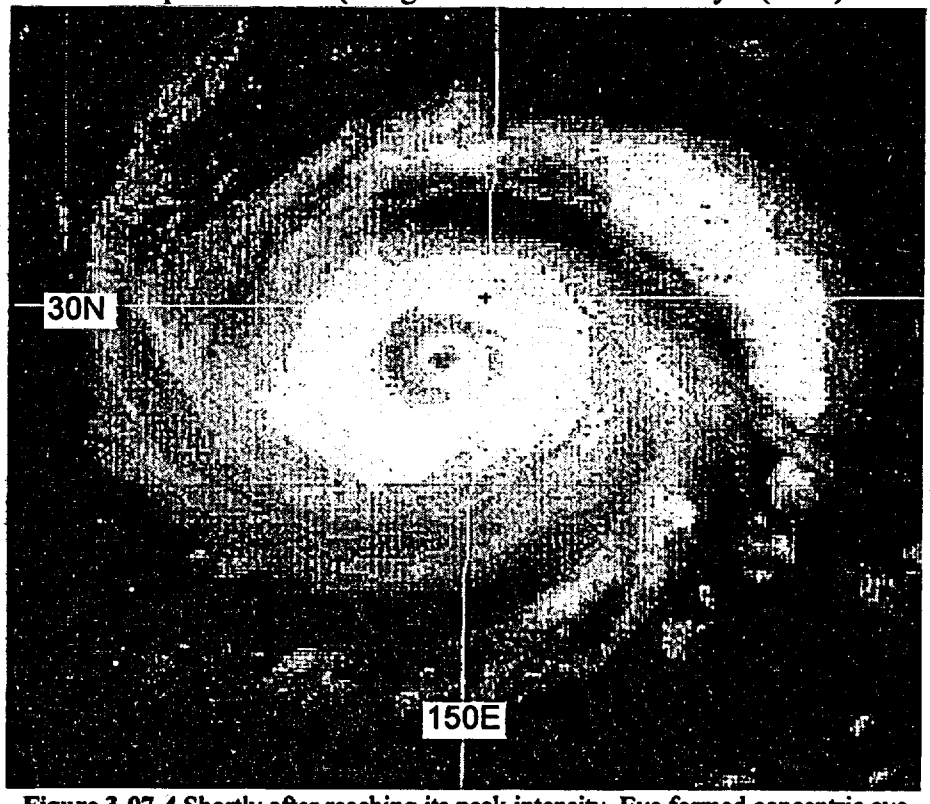

Figure 3-07-4 Shortly after reaching its peak intensity, Eve formed concentric eye walls. The relatively cloud-free moat between the eye walls resulted in a substantial drop in the default values of the DD number (160331Z July visible GMS imagery).

intensity estimates was 87 mb in 18 hours, resulting in an average decrease of 4.8 mb/hr. The explosive deepening was not anticipated, and 24-hour and 48-hour forecasts of Eve's intensity fell short by as much as 70 kt (36 m/sec) and 90 kt (46 m/sec) respectively during the two days prior to the event.

c. *A discussion of Eve's DD time series*

Infrared imagery is available hourly from the GMS satellite, and hourly DD numbers were calculated for all of the typhoons of 1996 (see Bart's (04W) summary for a detailed description of the DD algorithm installed on the JTWC's satellite image processing equipment). The discussion of the behavior of the time series of the DD numbers for Eve, and for some of the other typhoons of 1996, is intended to highlight certain aspects of the DD time series that may prove to have important research and/or warning implications.

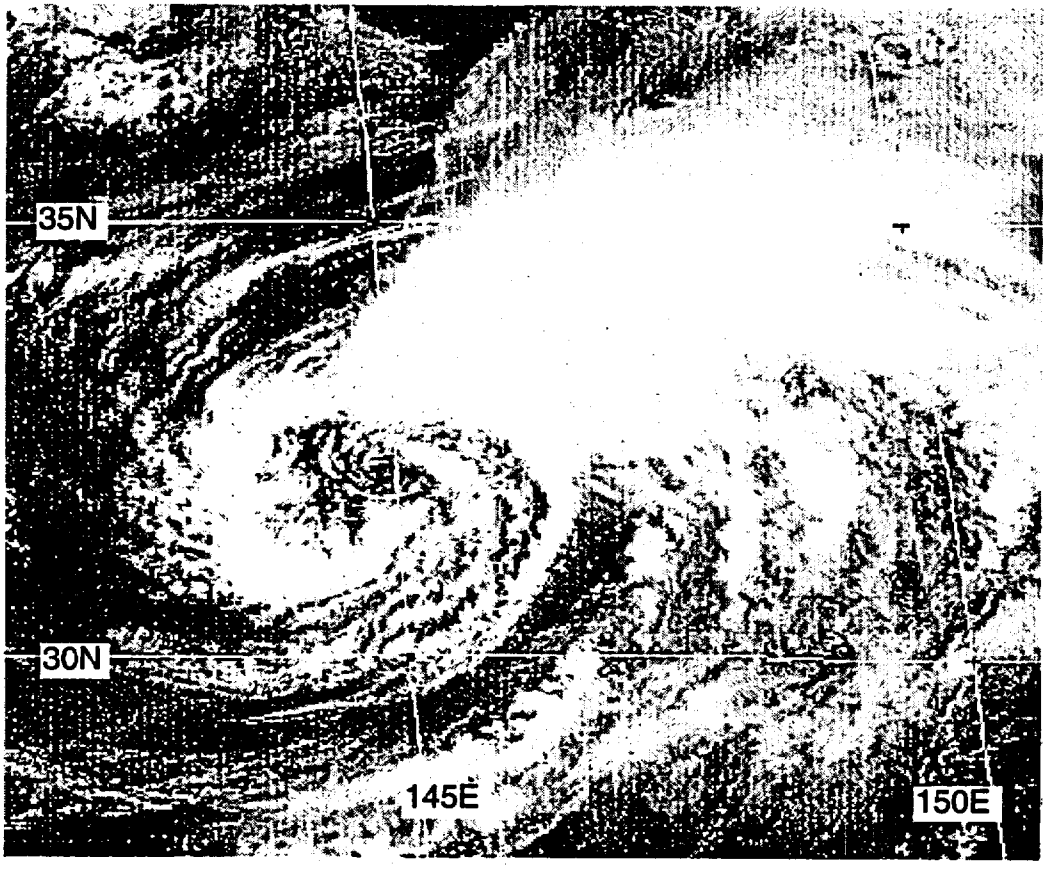

Figure 3-07-5 Exhibiting a Dvorak "shear" pattern type, Eve has regenerated and reached tropical-storm intensity after moving back over water to the east of Japan (220231Z July visible GMS imagery).

Eve is one of only a few cases during the past two years in which a strong diurnal cycle can be found in the time series of its DD numbers (Figure 3-04-6): higher DD numbers occur in the early morning hours (around 1800Z), and lower DD numbers occur in the late afternoon (around 0600Z). Although the DD number is based upon both the cloud-top temperature of the eye-wall cloud and the temperature within the eye, the apparently cyclical fluctuations in Eve's DD time series are linked more to major structural changes of the TC rather than fluctuations in the cloud-top temperatures of an otherwise stable cloud pattern. During the rise to the first DD peak during 15 July, Eve's eye evolved from a banding eye to a well-defined small eye. The fall of the DD numbers on 16 July is predominantly a manifestation of the formation of concentric eye walls. The default radius used to define the eye wall cloud-top temperature in the DD algorithm is 30 nm. When Eve

possessed concentric eye walls, this radius fell in the relatively cloud-free moat between the inner and outer wall clouds, and resulted in the period of low DD values after the first peak. The radius used to define the eye-wall cloud-top temperature is an adjustable parameter on the MIDDAS system, and when set to 10 nm it was able to measure Eve's intensity based on the cloud-top temperature of the inner eye wall. This resulted in DD numbers approximately one T number higher than those computed using the default radius when Eve possessed concentric eye walls.

Thus, while diurnal fluctuations of the intensity estimate of a TC may be the result of the general observation that cloud-top temperatures of deep convection in the tropics tend to be coldest in the early morning, the diurnal fluctuations of Eve's DD time series can be linked to major structural changes of the eye which may have only coincidentally occurred at the diurnal time scale. A similar sharp rise of the DD time series to a peak of over T 7.0 followed by a drop to near T 5.0 (due to the formation of concentric wall clouds) occurred with Dale (36W). In the case of Dale (36W), the timing of the rise and fall of the DD time series was 180° out of phase with that of Eve and with the generally observed diurnal cycle of tropical cloud-top temperatures.

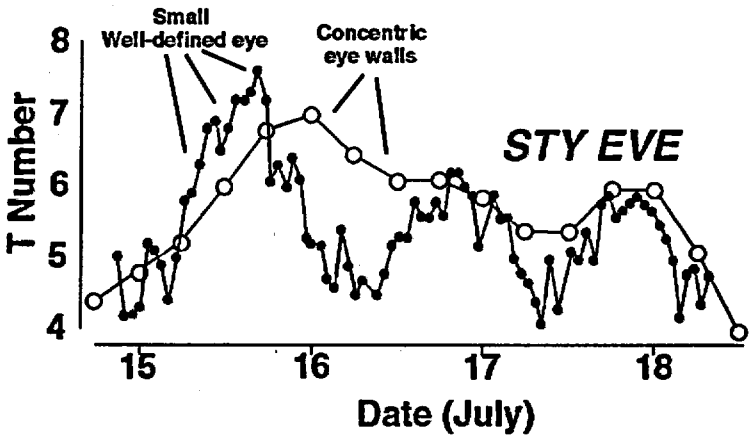

Figure 3-07-6 The time series of Eve's hourly DD numbers (small black dots connected by thin solid line). For comparison, the final best track intensity at six-hour intervals (converted to a T number) is superimposed (open circles connected by thin solid line).

IV. IMPACT

Strong winds and heavy rains affected the Japanese island of Kyushu, disrupting sea and air transport. Nine people were reported injured. The eye of Eve passed directly over the island of Yaku Jima (WMO 47836) in the northern Ryukyus where reports of wind gusts to 83 kt (43 m/sec) were received at the JTWC.